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A REVIEW ON FACTORS INFLUENCING CONSTRUCTION PROJECT SCHEDULING

R. Vidhyasri
P.hD. Research Scholar, Department of Structural Engineering,
Annamalai University, Tamil Nadu, India

R. Sivagamasundari
Assistant Professor, Department of Civil & Structural Engineering,
Annamalai University, Tamil Nadu, India

ABSTRACT

Construction scheduling is a complex and challenging task demanding an in depth expertise. Consideration of several factors, their influences and likely impact on the schedule need a thorough understanding. It is mostly experience based knowledge in the form of heuristics, available with the experienced schedulers. In this connection this study mainly discusses the factors influencing construction scheduling and techniques through a comparative study of various international construction projects. About 40 relevant articles published over the last 25 years have been reviewed. However, each and every limited formalized knowledge is available in theoretical form, which is interesting to many researchers for many decades, a comprehensive research is made and a comparative study on the literatures was carried out and presented in this paper. The main aim of the paper is to highlight the major factors which are to be mainly considered for the successful completion of the project.

Key words: Construction schedule, attributes, Knowledge map, construction projects.

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1. INTRODUCTION

It is well known that construction is an incredible game of risk. Before starting a construction project, proper planning and scheduling are needed to bring out the construction activities in a sequential manner. Even though it was clear that internal and external problems will affect the actual accomplishment of the schedule. Scheduling is a vital part of life and most important part of every plan and in other words it is the time table of work. It directs the managers in a right path towards their goals. It involves charting the requirements for the resources or the progress anticipated in completing components activities over the projects consumption of time.

Framing inaccurate work schedules leads to unnecessary issues in the construction of project and this will result in uncertainties which will result in overruns of time on the project work. Timing resources utilization and reliability schedules have to cope up with the work plan and work schedules of the field survey. Error in the work schedule may result in cost overrun, low quality standard and poor schedule performance index. Crashing and hasty actions are to be addressed due to poor scheduling process as well as increase in cost and shoddy work and late completion of the projects. The factor that majorly affects the work schedule is to be ascertained and examined which affects the development of the reliable and apt schedule which are very much pre found for effective project timetable, project tracking and project success.

Scheduling of construction projects is an involvement exercise based on a number of parameters, attributes and various factors. These factors and attributes are to be judged and considered appropriately by involving expertise and experienced professionals since the involvement of professionals and community seems to be very important in making a successful project.

The factors influencing construction schedule vary to a greater extent from people/staff attitude and behavior, the current timeline status, financing mode, completion pressure and requirement urgency, which all make the spread of factors very wide. Each factor contributes some influence on scheduling to the maximum extent. Hence, the scheduler and schedule making should have a full pledged wider perspective of all aspects which contribute to the project. Practically, a person cannot have specialties on too many things, rarely on experts' opinion and consultations, which is properly integrated for formulation of the schedule

Identifying the factor, its impact and contribution is the only way to finalize the schedule. The accuracy of knowledge on the quality of the factor and the measurability of the contribution makes it worth. However, understanding the complex nature of these factors their relationship and their influences are time consuming and requires dedicated efforts.

Since 1990 various researchers have taken interest in identifying and studying most of the factors contributing to planning and scheduling. The identified attributes have been classified, grouped and categorized into various forms such as critical, important and relevant ones using various approaches and methodologies. Finally it has been concluded with the approach of accounting the impact of the factors in the scheduling process by creation of model using statistical analyses. In the present study, an effort has been taken to review the literature related to construction scheduling and bring out the authors' findings and the methodologies followed by them for their innovations.

2. OBJECTIVES OF THE CURRENT STUDY

According to the nature of the study, an exploratory and descriptive research design can be adopted. If a problem or an issue has not been defined properly it is termed as exploratory research. Exploratory research helps to determine the best research design, data collection method and selection of subjects. While descriptive research, also known as statistical research, describes data and characteristics about the population or phenomenon being studied. Descriptive research answers the questions who, what, where, when and how. Thus, on the basis of the above, the two research designs were appropriate for the present study as it was important to gauge the various project specific risks that impact the software projects and also understand the dynamics of organization on these software projects this paper mainly reviews the paper based on the former method. The objectives of the study are as follows: 1. To review relevant literature in order to identify the factors influencing construction project scheduling and 2. To discuss their suggestions to improvise proper scheduling through different methods.

3. HISTORICAL BACKGROUND OF SCHEDULING ISSUE

The success of a project depends on participants, scope of services, project size, sophistication of the owner related to the design of facilities, technological implications, and a variety of other factors as it often changes from project to project. It is a challenge for the managers to find an accurate work schedule and not to take ineptitude and mobility into consideration which are the key factors which affect work scheduling. It is said that construction projects with effective work schedule are considered to be recipe for progress monitoring and control. It depicts the activities that have to be performed on a time scale. If the work activities are not scheduled, it would be difficult to monitor the progress of activity and to take corrective measures to prevent Milestones. Therefore the preplanning and proper scheduling of construction activities are needed to govern a project.

3.1. Literatures in Early 20th Century

From the vast literature survey, it has been observed that the researchers predicted the project success factors using Integrated Building Process Model (IBPM) (Victor Sanvido, 1992).By testing these factors on the projects; the results were obtained and correlated between success of the project and achievement of the factors. It has also been suggested that the success of the project depends on certain expectation of a particular participant whether owner, planner, engineer, contractor or operator. Later on, it has been observed that the project success also depends on time, cost and quality (Sharmil G.Naoum, 1994). The central hypothesis proposed is that the project performance is a function of matching the procurement method selected by the client and project characteristics.

Mansfield (1994) suggested that Cost overruns are attributed to finance and payment arrangement, poor contract management, material shortage, inaccurate estimators and price fluctuation. It has also been recommended that project management could be improved in developing countries at the planning stage of the project itself.

Daniel W.M Chan and Mohan M. Kumaraswamy (1996) identified the time overruns as a project. A questionnaire survey based on 83 identified delay factors, grouped into 8 major factors was prepared and the responses from the construction personnel were perceived using statistical analysis such as mean score method, the analysis of the collected information has been carried out and then correlated using Spearman's rank correlation coefficient. After that the results have been analyzed using the "relative importance index" technique together with rank agreement and the conclusions were derived based on the analysis (Chan, 1997).

Factor analysis technique has been developed to analyze the delay and cost overrun variables (kaming, 1997). As an advance in analysis, using Kendall's coefficient of concordance a strong agreement has been achieved between quantity surveyors. (Elhag, 1999). This study laid a foundation for the future researchers aiming to develop tenders price estimation models in which the cost and time attributes were involved.

3.2. Extension of Research on 21st Century

By Augustine uche Elinwa and Mangvwat (2001) studied the factors that affect time overrun in the Nigerian Construction industries. The study shows clearly that 62% of the time overrun is due to non-payment of materials because of a hefty material fluctuation, wrongful and abrupt termination of contract because of selfishness/greed, government policies and instability in the system, and not honoring payment certified for completed works. Mode of financing and payment for completed work, improper planning, and underestimation of time/duration for projects were identified as topmost factors.

AbdallaM.odeh, and HussienT.Batlaineh (2002) identified the most important causes of delays in construction projects with traditional type contract from the viewpoint of construction contractors and consultants. It has been found that contractor's and consultants agreed that the owner interference, inadequate contractors experience, financing and payments, labour productivity, slow decision making, improper planning and subcontractors are among the top ten most important factors. Relative important index was used to rank the factors. Spearman's rank correlation coefficient was used to test the association between the contractors and consultant ranking. The causes were then categorized into 8 major groups. They were client related factors, contractor related factors, consultant factors, material factors, labor and equipment factors, contract factors, contractual relationship and external factors.

Yam Frimpong, *et .al* (2003) in his paper presented the results of a questionnaire survey conducted to identify and evaluate the relative importance of the significant factors contributing to delay and cost overrun in Ghana groundwater construction projects. From the preliminary investigation 28 factors were designed into questionnaire and five most important factors agreed by owners, contractors and consultant as main causes were monthly payment difficulties, poor contractor management, material procurement, poor technical performance and cost escalation of material price. It has been concluded that effective project planning, controlling and monitoring should be established to enhance project performance in order to minimize or avoid delay and cost problems in groundwater construction projects.

Albert P.C. Chan *et.al* (2004) aimed to developed conceptual framework on CSF (Critical Success Factors). They chose 7 major journals in the construction field for their literature study. CSFS were grouped under main categories these factors were identified as critical to project success. Those are human related factor, project related factor, project procedures, project management actions and external environment. This paper focused only on CSFS and not on the measurement of project success.

P.A Koushki, *et.al.* (2005) determined the time delay and cost increase associated with the construction of private residential project in the state of kuwait.400 randomly selected private residential formed the database. They identified changing of orders, owner's financial constraints, and owner's lacks of experience are the main causes of time delay. Contractors related problem, material related problem and owner's financial constraints were the main reasons for cost over runs. They recommended minimizing the time and cost overrun. The projects required availability of adequate funds, allocation of sufficient time and money at the design phase and selection of a competent consultant and reliable contractor to carry out the work.

ArshiShakeelFaridi and Sameh Monir El-sayegh (2006) identified top 10 most significant causes of construction delay. Of the top 10, five causes fall under the category of contractor which implied that contractor can be held responsible. Shortage of resources was also found to be a major cause along with shortage of manpower, productivity of manpower and skill of manpower. Some recommendations like presence of agreed schedule between contractor and consultant for preparation, Submission and approval of drawings involvement of construction management companies and better human resources management can help improve labor skill and productivity.

K.C Iyer and K.N Jha (2006) identified 55 attributes impacting the performance of projects. After the analysis of the responses from the two stages questionnaire survey, they concluded and commitment of project participants, owner's competence as two success factors: and conflict among project participants as one failure factor and contributed significantly in enhancement of current performance level of the project.

G.Sweis, *et.al* (2008) indicated that financial difficulties faced by the contractor, too many changes order from owner and poor planning and scheduling of the project by the contractor continue to be the major sources of residential project delay in Jordan. Using the terminology of the drewin's open conversion system, it can be clearly argued that major delay causes are related to the environment of the system especially that of the contractor, and the input factors relating to the labor, while the exogenous factors have very little or negligible effect on project delay.

LuciusBaloyi and MichielBekkar (2010) investigated the causes of cost overrun and time delay during the upgrading and construction of the various stadia. A three tier- research approach covers a comprehensive literature review on the causes of cost overruns and time delays on construction-related projects globally as well as investigated into the factors that caused cost overruns and time delays on six of the stadia. Finally the results for the global and stadia projects are compared. The results indicated that the increase in material cost in the single largest contributes to cost overruns for both global and stadia projects with respect to time delay in payments while for the stadia projects related factors cause the most delay. The result provides valuable information on the unique challenges facing those who are interested in investing or managing construction projects in South Africa.

Engr.(Mrs) UchennaUgochiMonke (2012) examined the factors affecting effectiveness of work schedule with the aim of providing a framework that will help managers to develop a reliable and cost effective schedule necessary for successful implementation and control of projects in Nigeria. The results of the analysis indicated that time, material and manpower were the significant factors. An in-depth time forecasting and scenario analysis as well as apt management of materials and human capital development have been recommended in this study.

Bon Gang Hwang and Lay peng Leong (2013) identified the degree of project delay in 220 traditional and 96 green construction projects in Singapore. They established that 15.91% of the traditional projects were delayed while 32.92% of the green construction projects were completed behind schedule. The top 5 factors causing delay in green projects were (1) Speed of decision making involving all of decision making of the client; (2)Speed of decision making involving all of the projects teams; (3) Communication/coordination between key parties; (4) level of experience of consultants; and (5) difficulties in financing the project by contractors.

M.Hannah and Dr.Srinivasan (2014) found that among the various difference factors studied, the project purely involves the effect of resources and its effect on the construction projects in India. The main effects of the resources are time-overrun, cost overrun, and conflict occurrence. Among these factors, the resources stand as very viable factors. The construction industry handles many resources such as money, men, machinery market, and material. If these are not properly used, generates time overrun, cost overrun, conflict etc.,

Bon-Gang Hwang *et.al.* (2015) identified the degree of project delay in 98 new green building projects and 51 retrofitting green building projects in Singapore. The result indicated that 22% of the green building projects were delayed and the retrofitting project had significantly longer extensions. They found that "Consultant Cooperation to Solve problems" was the most influential to schedule performance in both the categories of projects.

3.3. State of the Art Developments in the Current Scenario

In the recent years, the intensified studies on these factors with more rigorous and robust analysis are carried out using sophisticated mathematical and statistical methods to quantify their significance. Integration of these factors using software at the planning level itself yields more accurate scheduling. More knowledge is desired by factorizing the concerned entity

which gives clarity on the likely consequences, and the quantity of their impacts on schedule. Utilizing these much more workable and realistic scheduling is carried out which improves the performance of project execution.

Ousseni Bayaandjinbo (2016) identified the most frequent, severe and important cause of schedule delay affecting public construction projects in Burkina faso, basically to enhance the managerial capability of project managers. After analyzing the results of the questionnaire sent out to 140 experts, using the quantitative statistical method, the top five most important delays were ranked: Financial capability of contractor, financial difficulties of owner, equipment availability of the contractor, slow payment for completed work and poor subcontractor performances by the contractor. To validate the result of this study they compared it with the scheduled delays found in 11 other countries. The financial capability of the contractor was found be the most encountered factor for delay.

4. IDENTIFICATION OF FACTORS INFLUENCING CONSTRUCTION SCHEDULING

An elaborate literature research on the factors influencing construction schedule has been carried out to determine the contribution of these factors related to the schedule. The critical factors that are influencing scheduling of different types of projects like residential, commercial, Industrial, Infrastructure in the construction industries in various parts of the world explored by various authors are shown in Table .1.The table clearly demonstrates that Formulation , design and scope, Clearances, Implementation and Finance were the influencing factors at the planning stage. Other factors including weather conditions, conflicts among the workers and safety measures were the influencing factors at the execution stage. Hence it is clearly understood that a knowledge map is required to know the sources of critical scheduling factors for the successful completion of the project. The identified factors are summarized and represented in the form of Factor graph as shown in Fig.1

Fig.2 shows the knowledge summary map representing the sources of critical scheduling factors. This flow chart consists of various factors influencing the schedule in each and every step of construction activities. Some are predictable and some are unpredictable. Whether predictable or unpredictable the factors should be accounted and determined to maintain the quality of the project and to finish it within the stipulated time along with the estimated cost.

Table 1 Discussions on Reviewed Literature

Sl. No.	Author / year	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	Geographical region	Types of Project	Tools as methods
1	By shamil and G.naoum (1994)					✓	✓					✓	✓		✓	✓	UK	Building	Statistical analysis
2	Peter F.kaming et.al(1997)	✓	✓		✓			✓	✓	✓			✓				Indonesia	High-rise projects	Factor analysis
3	By Augustine ucheelinwa and Mangvwat Joshua (2001)		✓	✓	✓	✓	✓	✓	✓			✓	✓		✓		Nigeria	Construction Industry	Statistical methods
4	Yaw frimpong et.al (2003)	✓		✓	✓			✓	✓		✓		✓	✓			Ghana	Groundwater projects	Spearman rank correlations
5	K.C. Iyer and K.N.Jha (2006)	✓	✓	✓			✓	✓	✓		✓	✓	✓				India	Construction projects	Multinominal logistic Regression model
6	G.Sweis et.al (2008)			✓	✓	✓	✓	✓	✓				✓				Jordan	Construction projects	SPSS (ANOVA)
7	Lucius Baloyi and MichielBekker (2010)		✓	✓	✓	✓		✓	✓				✓	✓			South Africa	Global and Stadia projects	RII
8	Bon-Gang Hwang ett.al(2012)	✓	✓	✓	✓	✓	✓	✓			✓						Singapore	Green Building Projects	RII
9	Hwang B.G et.al(2013)	✓	✓	✓	✓	✓	✓	✓	✓		✓					✓	Singapore	Green Building projects	Spearman rank correlations
10	M.Hannah and Dr.G. Srinivasan (2014)							✓									India	Construction Industries	SPSS
11	Hwang B.G et.al(2015)	✓	✓			✓	✓	✓				✓	✓				Singapore	Building projects	Spearman rank correlations
12	OusseniBaya and Jinbo (2016)	✓		.	✓	✓	✓	✓	✓					✓	✓		Burkrina Faso	Public construction projects	RII

F1	Formulation	F6	Teams	F11	Conflicts
F2	Design & Scope	F7	Resources	F12	Planning
F3	Implementation	F8	Environment	F13	Price
F4	Clearances	F9	Safety	F14	Time & Cost
F5	Finance	F10	Delay	F15	External

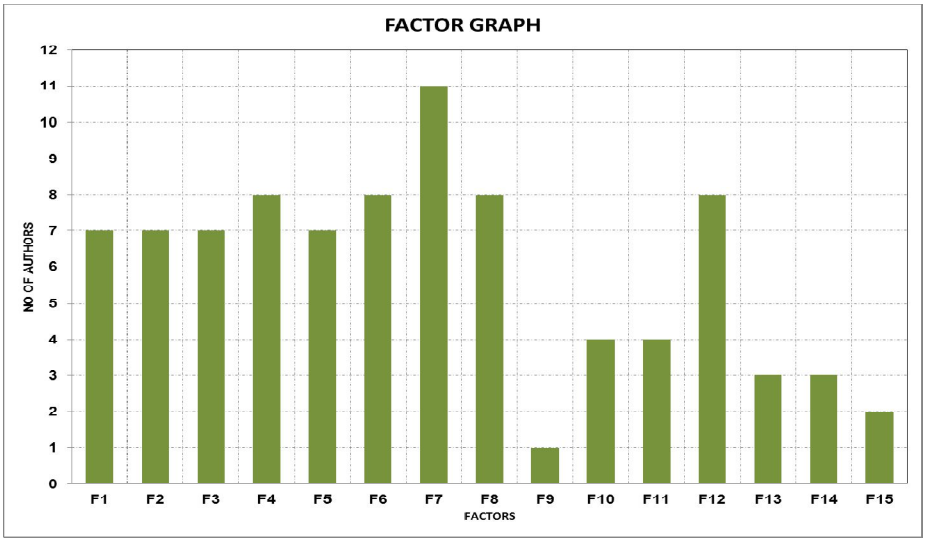

Figure 1 Factors influencing construction scheduling – Perception of researchers

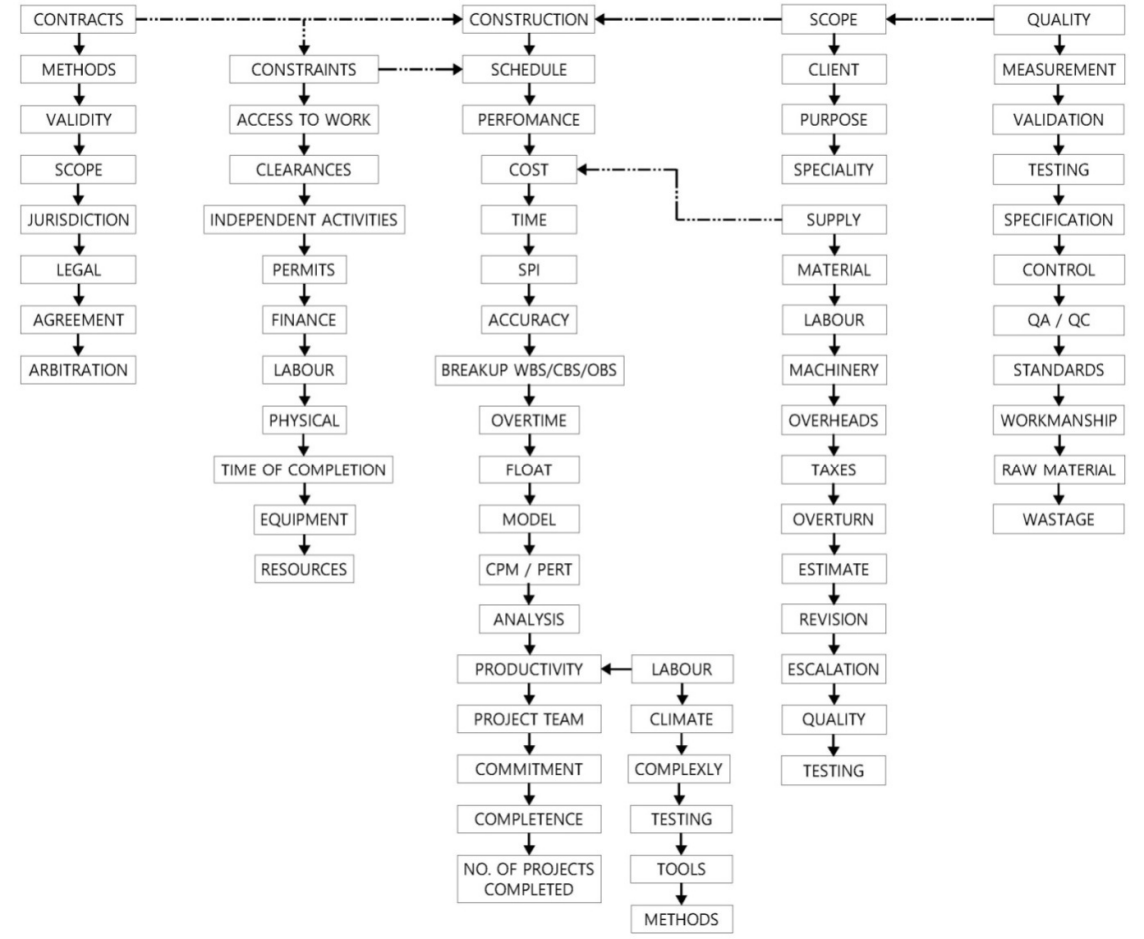

Figure 2 Knowledge summary map representing the sources of critical scheduling factors

Literature survey briefs that most of the researchers have determined that the resources availability, management and deployment of labour, equipment and material are the most important factors that determine and contribute to the schedule performance. The next three to four important factors studied by the researchers were resources availability, weather climate, clearance approval and government regulations, planning monitoring and control system. Some factors such as related safety, other external factors as, etc. were contributing little lesser than the above.

5. SCHEDULING TECHNIQUES

Hodgetts (1979) proposed that Gantt chart is simple and efficient format but cannot be used to handle the complex projects with many activities and to depict the interrelationship of project activities. So that it has given way to tools such as CPM and PERT.

Sanvido et al., (1990) identified a generic integrated process model of the activities. The model includes the managing, planning, design, construction and operations of a facility. This report introduced computer integrated construction (CIC) to handle the various activities of the project.

Stevenson (2002) Postulates that regression analysis is an associative technique which relays on identification of related variables that can be used to predict of the variables of interest.

Deepika K. Sankhe and Mariappan Dharmaraj Nadar(2008) applied Genetic algorithm to scheduling problems. These are strict requirements to time frames and budget cost for

projects. Project Management cause the problem of efficient resource assignment, Activity, time Constraints and relationship between activity. Daniel Castro-Lacouture et.al (2009) evaluated the viability of using fuzzy mathematical model for determining construction schedules and evaluation the contingencies created by schedule compression and delay due to unforeseen material shortages.

Vitaly Semenov and Anton Anichkin (2013) created a new WWCPSP(Work Flow Constrained Project Scheduling Problem) generalizing the classical RCPSP (Resource Constrained Project Scheduling Problem)by taking into account the spatial factors that has been stated and formalized. The effective scheduling method for the problem has been proposed, investigated and approved. Like the classical approaches it tends to minimize the project make span while satisfying timing constraint, precedence relations and not exceeding resource utilization limits.

Poonam Raykar and Ghadge (2016) used project management techniques such as, fishbone diagram, effective material management, resource smoothing and leveling, monitoring and scheduling. Proper coordination between the parties has been suggested for the satisfactory completion of a project.

A comprehensive model and a framework for selecting an appropriate factor for the project specific approaches were very much limited. It is attempted to consolidate the various methods of approaches and the suggested framework by various co researchers and to develop a project specific decision support methods for Indian infrastructure and construction in this paper. A thorough detailed study on the parameters that have governance on the project through reported literatures was carried out. A rational framework and a template for identification, selection, model, analysis, and accounting is evolved and developed for direct use by professionals with potential research gaps.

6. SUMMARY AND CONCLUSION

This paper presents the various attributes and factors that are influencing the construction scheduling through a vast literature study. For the past several decades, steps have been taken by several researchers to identify the key factors that are affecting or influencing the construction project scheduling which in turn leads to the failure of the project completion within the stipulated time and cost. The factors such as resources availability, weather climate, clearance approval and government regulations, planning monitoring and control system, seem to be top most factors the factor such as safety, price escalation and profitability, time and cost overruns seem to be least factor. This paper also deals with a variety of analysis which has been adopted by different authors for the collected data from the construction industries. From the literature review it has been clearly shown that a lot of analytical approach have been tried by several authors since 1990- 2016 such as statistical computing package(MINITAB), Importance index, Severity Index, RII, Factor Analysis, Severity Index, Linear Regression Model Statistical analysis, RII, Factor Analysis, SPSS, RII, ANOVA T-test, Spearman Rank Correlation, Factor Analysis, RII, SPSS,PERT,CPM, Line of Balance Scheduling, Space Scheduling, Dynamic Layout Scheduling, Horizontal and Vertical Logic Scheduling, MS Project, Primavera, Newton Software, Fishbone Diagram, Fuzzy Mathematical Model, Linear Scheduling Method, Genetic Algorithm Meta-Heuristic Procedure. Among them SPSS has been adopted frequently by many authors and it has been suggested that it holds well in various aspects of data analysis. The findings from the review are presented in the form of tables & charts. Table 1 discusses about the critical scheduling factors identified by researches in various construction projects. Then a knowledge map is developed and it is shown in fig 1. It represents the sources of the critical factors in construction project which affect the project success. An extensive literature survey revealed

that researchers have shown a remarkable contribution towards identification and assessment of critical scheduling factors. Anyhow, it is unfortunate to observe that there is a gap between the theory and practice. In India still this problem exists and therefore this paper recommends that the pivotal identification of the scheduling factors are needed. Then a frame work is to be designed for quantifying the factors considering the uncertainties. It is necessary to develop a simple statistical model for factor assessment in construction projects considering small and medium sized projects also. Finally suitable recommendations are to be suggested, to mitigate the risks during the life cycle of the project to make successful projects.

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